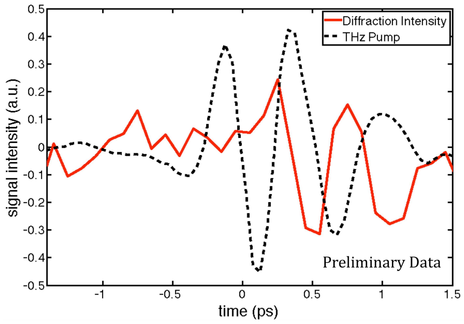
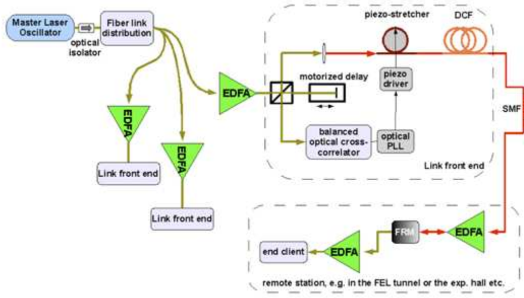
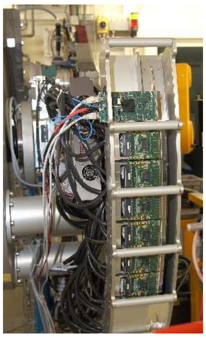


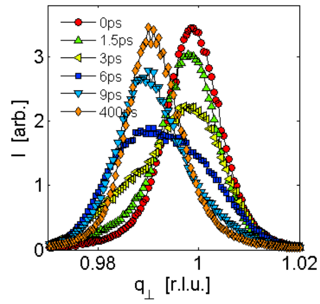

SWISS LIGHT SOURCE SLS



# SLS Symposium on

# Towards XFEL




**Tuesday, November 6, 2012**

**10:00 to 12:15, WBGB/019**

**10:00 Ultrafast dynamics of magneto-structural phase transitions**
*S. O. Mariager, A. Caviezel, P. Beaud, S. L. Johnson, S. Grübel, J. Johnson, C. Quitmann, G. Ingold*

**10:30 Charge integrating silicon detectors for SwissFEL**
*A. Bergamaschi, S. Cartier, R. Dinapoli, D. Greiffenberg, B. Henrich, I. Johnson, D. Malikal, A. Mozzanica, C. Ruder, L. Schaedler, B. Schmitt, G. Tinti, X. Shi*

**11:00 Coffee**

**11:15 Femtosecond synchronization for SwissFEL**
*M. Kaiser, V. Arsov, S. Hunziker, and V. Schlott*

**11:45 THz pump and Ultrafast X-ray Diffraction Probe of Collective Excitations**
*T. Kubacka, J. A. Johnson, S-W. Huang, S. Gruebel, L. Huber, P. Beaud, G. Ingold, M. C. Hoffmann, J. J. Turner, G. Dakovski, M. Minitti, W. Schlotter, S. de Jong, W-S. Lee, Y-D. Chuang, R. G. Moore, S. Koohpayeh, C. Vicario, C. Hauri, L. Patthey, S. L. Johnson, U. Staub*

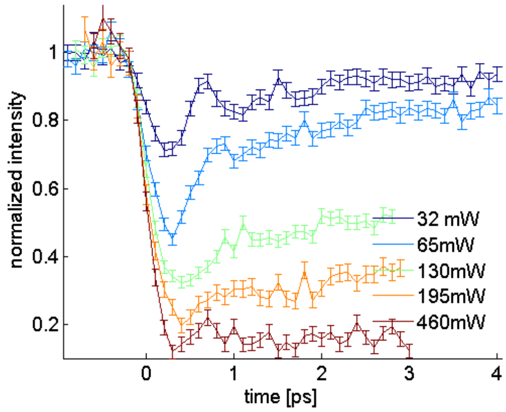
# Ultrafast dynamics of magneto-structural phase transitions

S. O. Mariager[1], A. Caviezel[1], P. Beaud[1], S. L. Johnson[2], S. Grübel[1], J. Johnson[1], C. Quitmann[1], G. Ingold[1]

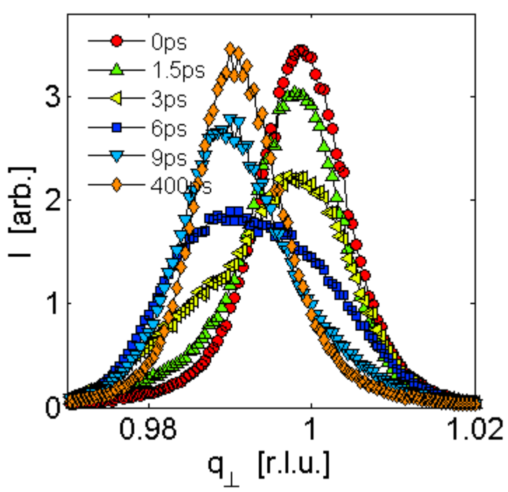
[1]Swiss Light Source, Paul Scherrer Institute, 5232 Villigen, Switzerland
[2]Institute for Quantum Electronics, Physics Department, ETH Zurich, 8093 Zurich, Switzerland

simon.mariager@psi.ch

There can be many reasons for performing ultrafast pump-probe experiments, but three common ones are: 1) In correlated systems where many degrees of freedom interact, the ultrafast excitation by a laser pulse might allow us to separate different interactions in time. 2) In the ever increasing arms race of modern technology pump-probe experiments are a direct approach to understand how and how fast matter can be manipulated. 3) For understanding phase transitions or chemical processes these experiments might reveal distinct pathways or transient phases. Using the FEMTO slicing we have studied two magneto structural phase transitions in time-resolved diffraction experiments, and based on these I will illustrate how the above mentionend motivation might be fulfilled.




*From optical phonons to ultrafast phase transition in $Ni_2MnGa$.*




*Bragg reflections measured at different time delays after laser excitation show the phase co-existence during the FeRh transition.*

The Heusler alloy $Ni_2MnGa$ is a magnetic shape memory alloy which ows its fascinating properties to the co-existence of ther structural martensititic transition and ferromagnetism, but while technical applications already exist the microscopic origin of the phase transition is not understood. With time-resolved x-ray diffraction and laser reflectivity [1] we have studied how the different structural components of the martensite phase evolve in time, as $Ni_2MnGa$ is excited through the martensitic transition with a fs laser. FeRh also has a peculiar magneto-structural transition and we have compared the structural and magnetic dynamics of the phase transitions two components: the anti-ferromagnetic to ferromagnetic change in magnetic order and the lattice expansion. This allowed us to develop a simple model describing the nucleation and subsequent alignment of the ferromagnetic phase [2].

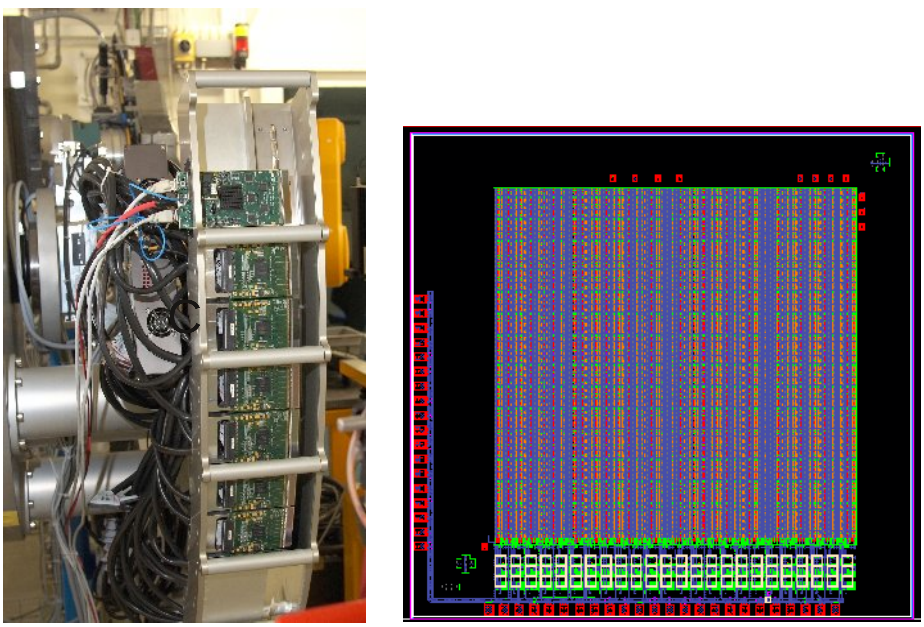
[1] *S. O. Mariager et al. APL 100, 261911 (2012)*

[2] *S. O. Mariager et al. PRL  108, 087201 (2012)*

**Charge integrating silicon detectors for SwissFEL.**

A. Bergamaschi, S. Cartier, R. Dinapoli, D. Greiffenberg, B. Henrich, I. Johnson, D. Malikal, **A. Mozzanica**, C. Ruder, L. Schaedler, B. Schmitt, G. Tinti, X. Shi

1D and 2D detectors based on charge integrating readout with automatic gain switching logic are being developed at PSI.
The systems are designed to provide a dynamic range of $10^4$ 12keV photons, single photon resolution down to a few keV photon energy and a noise lower than 200 e.n.c. .
The GOTTHARD 1D miscrostrip detector module, which is under commissioning, is composed of a printed circuit board housing 10 readout chips for a total of 1280 channels at 50μm pitch. A complete readout chain, from the high speed ADCs to a Gbit link for the data download to the control PC, is also integrated on the board. Frame rates up to 60kHz (continuous) and 1MHz (burst) are achievable with the system.
The JUNGFRAU 2D detector, which is expected to be deployed in 2015, will have a 75μm pixel pitch and a modular construction similar to the (PSI developed) EIGER photon counting detector. A prototype readout ASIC with 48x48 channels has been designed and will received by the end of the year.
Results from the characterization measurements of the GOTTHARD system and the design of the JUNGFRAU prototype system will be reported together with an outlook on the new possibilities made available by charge integrating detectors in a Synchrotron source environment, with particular focus on high rate and high resolution applications.



*Picture of a GOTTHARD 1D detector module under test in the MYTHEN detector array at the SLS MS beamline (left) and CAD drawing of the JUNGFRAU01 pixel prototype with 48x48pixel at 75μm pitch currently under production (right).*

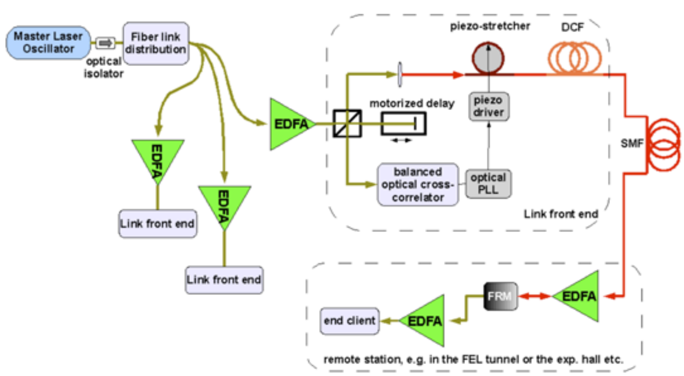
# Femtosecond synchronization for SwissFEL

***M. Kaiser**, V. Arsov, S. Hunziker, and V. Schlott*

*Paul Scherrer Institute, 5232 Villigen PSI, Switzerland*

*maik.kaiser@psi.ch*

Free-electron Lasers (FELs) have the potential for new scientific discoveries from fundamental research to applied sciences. The FEL currently under construction at PSI (SwissFEL) will be a source of extremely bright and short X-ray pulses in the wavelength range from 1 to 70 Å (~200 eV to 12.4 keV) with a pulse length of below 15 fs (rms) at a repetition rate of 100 Hz. The underlying machine, a linear electron accelerator of several hundred meters in length, serves the undulator lines in order to produce these x-ray pulses. The electron bunches are injected with a short-pulse laser in a high-field RF cavity photocathode gun. After compression their bunch length should be comparable to the aimed X-ray pulses. In order to reach such short bunches, different components distributed along the machine need to be synchronized in time down to this level. This necessitates a distribution of a highly stable timing reference and the synchronization of elements such as the gun laser, low-level and RF stations and the experimental laser to this timing reference with stability in jitter and drift in the lower femtosecond (sub-10fs) range. Furthermore, longitudinal diagnostic systems such as bunch arrival-time monitors (BAMs) will use directly the pulsed timing reference to measure the arrival time of the bunches with fs accuracy.
Depending on the stability requirements of the different clients, the topology of the timing reference distribution will be a mixture of pulsed and CW optical distribution as well as electrical sub-distributions for cost-effective solutions. The synchronization of the various elements can therefore be electrical as well as optical. The concept of the timing reference distribution together with the possible synchronization schemes and their stability limits will be presented along with examples of laser synchronization and fiber-optic link stabilization.




Layout of the link-length stabilization for drift-free distribution of the optical reference pulses.
EDFA - Erbium doped fiber amplifier, PLL - Phase-locked loop, DCF - Dispersion compensating fiber, SMF – Single mode fiber, FRM – Faraday rotating mirror.

**References:**

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[2] S. Hunziker *et al.*, Proceedings of the IRUVX Conference, Ultra-stable synchronization system development for FEL-sources: over view, status and perspectives, Doellnsee-Schorfheide, Germany, 2010.

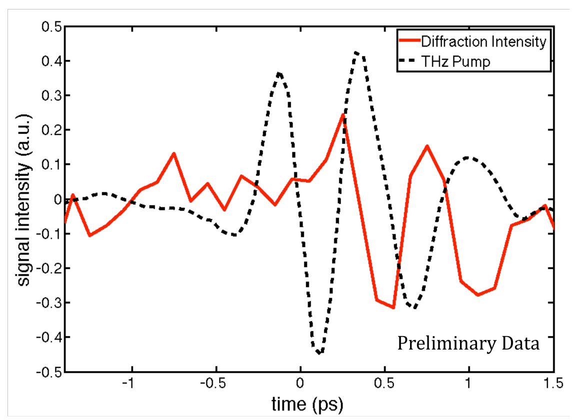
# THz pump and Ultrafast X-ray Diffraction Probe of Collective Excitations

T. Kubacka[1], J. A. Johnson[2], S-W. Huang[2], S. Gruebel[2], L. Huber[1], P. Beaud[2], G. Ingold[2], M. C. Hoffmann[3], J. J. Turner[3], G. Dakovski[3], M. Minitti[3], W. Schlotter[3], S. de Jong[3], W-S. Lee[4], Y-D. Chuang[5], R. G. Moore[6], S. Koohpayeh[7], C. Vicario[8], C. Hauri[8], L. Patthey[8], S. L. Johnson[1], U. Staub[2].

jeremy.johnson@psi.ch

[1]Institut für Quantenelektronik, ETH Zürich, Switzerland
[2] Swiss Light Source, Paul Scherrer Institut, Switzerland
[3] LCLS, SLAC National Laboratory
[4] Stanford Institute for Materials and Energy Science, SLAC National Laboratory
[5] Advanced Light Source, Lawrence Berkeley National Laboratory
[6] Stanford Synchrotron Radiation Light Source, SLAC National Laboratory
[7] SwissFEL, Paul Scherrer Institut, Switzerland

Ultrafast pump-probe measurements offer insight into fundamental physical and chemical dynamics at the shortest time scales. In order to fully understand ultrafast measurements and avoid confusion as to the observed dynamics, selective pumping schemes can provide important clarity. Resonantly exciting THz frequency collective excitations promises a more extensive understanding of the physics in materials. An ultrafast probe that is sensitive to particular degrees of freedom will likewise enhance what we can learn. A selective probe is particularly important in strongly correlated electron systems, such as multiferroic materials, where modes of different origin can be strongly coupled. Ultrafast x-ray sources offer such a selective probe. Our groups have made progress with laser pump, x-ray probe measurements [1-6], and we recently made a successful foray combining broadband THz excitation with x-ray probing at the LCLS free electron laser. Utilizing resonant soft x-ray diffraction, we were able to probe the ultrafast magnetic dynamics in multiferroic $TbMnO_3$ after excitation with broadband THz radiation. The THz pulse resonantly drives an electromagnon [7], the fundamental multiferroic excitation that describes the coupling of magnetism and ferroelectricity. Using soft x-ray pulses (~650 eV) we were able to directly probe the magnetic character of the electromagnon, allowing us to observe the time evolution of the magnetic order with the femtosecond x-ray pulses. Important experimental considerations key to the success of such measurements will be discussed. These experiments provided a successful demonstration employing THz pumping and x-ray probing of dynamics in the solid state, and offer direction for future studies of ultrafast THz/x-ray measurements.




*The THz electric field excites the electromagnon in TbMnO3 and the magnetic order is probed by resonant x-ray diffraction.*

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